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BULLETIN

OF THE SOCIETY OF ARTS

FEBRUARY 1909

LECTURES IN FEBRUARY

657th Meeting
February 11th

Darwin Memorial Meeting to be addressed by Prof. Percival Lowell and Prof. W. T. Sedgwick, Huntington Hall, February 11th, at 8 o'clock. Professor Sedgwick, who is at the head of the department of biology at the Institute of Technology, will speak of organic evolution, and Professor Lowell, non-resident professor of astronomy at the Institute, will take the inorganic side. All are welcome.

658th Meeting
February 27th

Prof. Charles E. Lucke, on "Gas Power," Huntington Hall, February 27th, at 8 o'clock. Dr. Lucke is at the head of the mechanical engineering department of Columbia University, and is conceded to be one of the highest authorities on gas power. His lecture will cover the whole field in a comprehensive way, going into details only when necessary.

DARWIN MEMORIAL MEETING

Charles Darwin, whose name is perhaps the greatest in the history of science in the nineteenth century, was born on February 12, 1809. His famous work, "The Origin of Species by Means of Natural Selection," was published in November, 1859, at the time when Professor Rogers was maturing his plans for that new type of educational institution which has since become the Massachusetts Institute of Technology. President Rogers was a strong supporter of Darwin from the outset, and when Darwin's

THE SOCIETY OF ARTS OF THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY

The Society of Arts was established as a department of the Institute by President Rogers in 1861.

It is especially devoted to the general dissemination of scientific knowledge and it aims to awaken and maintain an interest in the recent advances and practical applications of the sciences.

Any person interested in the aims of the Society is eligible to membership. The annual dues are $3.

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supporters were few and far between. In the meetings of the Boston Society of Natural History, in particular, Professor Rogers took a leading part in the debates of the day, warmly defending Darwin and his theories.

The Institute, which has come into existence, and grown to its present proportions since that time, is itself a witness to the marvelous growth of the scientific spirit for which Darwin then stood, and for which Darwinism and evolution stand to-day.

It has seemed fitting that the next meeting of the Society of Arts should be given up to a commemoration of the centennial of Darwin's birth, and for it two speakers have been selected, one Professor Sedgwick, the head of the biological department of the Institute, who will give an account of Darwin's life, and his influence upon organic evolution, the other Dr. Percival Lowell, non-resident professor of astronomy, and director of the Lowell Observatory at Flagstaff, Ariz., who will discuss the influence of Darwinism in clearing the way for an acceptance of the broader aspects of evolution, particularly as applied to cosmology.

The following is an outline of some of the topics to be treated by Professor Lowell:—

Evolution classed as organic and inorganic; somewhat paradoxically since its ultimate outcome is the oneness of the two. Growth the fundamental characteristic of the universe. A long line of inorganic development culminating in the organic. Slowness of man to perceive this due to his self-centred attitude. Gradual widening of his horizon as he himself evolved. Grandeur of the spectacle thus disclosed. Sketch of the history of its growing comprehension. Nebular Hypothesis. Kant, Laplace, Faye, Ligondis. Stellar evolution; Lockyer. Connection of the inorganic with the organic. Darwin. Origin of species. Function of genius the changing of the world's point of view. Difficulty of reception. Inertia of mind as deep a principle as inertia of matter. An idea a force needing time to gain momentum. Recognition of great men after they are dead. Solitariness of genius when alive. The unaccepted of the day become the established of the morrow. Darwin typical of this. The truest tribute to such the unshackling of the mind from the prejudices of the past.

DR. LUCKE ON "GAS POWER"

The enormous demands which the present age is making upon our sources of power is arousing increased interest in the more economical utilization of those we have and the development of new ones.

One line of development which seems to promise valuable results lies in the use of the gas generator and internal-combustion motor or gas engine as a substitute for the steam boiler and engine. Another lies in the complete elimination of the boiler and the direct injection and combustion of the fuel in the cylinder of the engine.

The very general use of the gas and gasoline engine in the smaller sizes for stationary, automobile and marine use, has resulted in a general realization of the possibilities of such engines.

That gas engines in units of several thousand horse-power capable of meeting the most exacting demands of electric lighting and similar service are possible is not so generally known. Such installations, while not so common in this country as in Germany, are not unknown. At San Mateo, California, three gas engines of 4,600 horse-power each, installed to act as a reserve to the hydro-electric system, are, since the earthquake, in regular service for 18 hours daily. The United States Steel Corporation, in their new plant, are using gas engines of equal power, running on the gas generated as a by-product in the manufacture of cast iron.

In his lecture on February 27th, Dr. Lucke will consider as non-technically as possible, the history of the development of the gas engine and the principles governing the operation of such engines. He will, also, discuss the economies possible by the use of the gas engine, the requirements to be met in different applications, and the structural characteristics necessary to adapt the engine to the different cases.

With the increased demand for, and consequent rise in price of gasoline, more and more attention is being devoted to the possibilities of the use of alcohol and the heavier petroleum products in the gasoline motor. The more general use of such fuels will admit of the more general introduction of farm motors, agricultural motors, etc. In the development and use of such aids this country is far behind Germany. Dr. Lucke is particularly well qualified to speak of this phase of the subject as it was at Columbia University, under his direction, that the investigations in the use of alcohol for internal-combustion engines were made for the Department of Agriculture. These investigations, made in the winter of 1906–1907, include, in addition to a study of all available tests made in France and Germany, a wide range of original tests made on American engines.

In addition to a wide experience as a consulting engineer and expert, Dr. Lucke has taken an active part in the research work connected with the development of the gas engine. He is the author of a very comprehensive book on "Gas Engine Design" as well as numerous papers presented before various societies. In January, 1907, he spoke before the Boston Electrical Engineers Society on the regulation of gas engines in electrical service. At the first meeting of the newly formed Gas Power Section of the American Society of Mechanical Engineers, in February, 1908, he acted as chairman and also presented a paper describing some improved apparatus of his for the study of fuel gases.

RESERVED SEATS

A number of seats are reserved at each lecture for members of the Society of Arts who write for tickets. The unoccupied reserved seats will be thrown open to the public at 7.55 o'clock promptly.

SOMETHING ABOUT THE CORROSION OF IRON

On Wednesday evening, January 13th, Dr. William H. Walker, Director of the Research Laboratory of Applied Chemistry of the Massachusetts Institute of Technology, gave a highly instructive talk upon the "Corrosion of Iron and Steel and Modern Methods of Preventing It." The following is a summary of his paper :—

The material which we usually term iron is unique in that it is never in reality the pure metal as is, for example, the case with copper, but is a mixture of iron and certain alloys of iron with other elements with which it unites during the process of its manufacture. These alloys or compounds, moreover, when present even to a very minute extent, have a controlling effect upon the physical properties of the resultant product. When the iron is first reduced from its ore, these impurities are present in relatively large quantities, and are removed by refining processes, which if carried on with the iron in a plastic condition results in what we term wrought iron, while if during the process of refining the mass is held in a molten condition, the material known as steel is produced. The iron of our forefathers was all made by the first method, and it cannot be denied that such material resisted corrosion, or rusting, as this phenomenon is usually termed, better than much of our modern steel; but inasmuch as we have now offered on the market both good and bad iron, and good and bad steel, the long discussion which has recently been carried on as to the kind of metal which resists corrosion better, is without any value whatever. It may be said, that if all iron and steel withstood corrosion as does *the best* iron and steel, there would be little interest in a further discussion of the subject.

The factors which determine whether a given sample of iron or steel will corrode rapidly or slowly, and the conditions upon which corrosion in general depend, may best be understood by first considering this phenomenon from a theoretical point of view. Every metal when placed in contact with water, has a certain tendency to pass into solution. This tendency to escape is known as solution pressure, and varies with the material. In a metal like sodium, this pressure is so great that instant solution occurs when the metal comes in contact with water, while in the metal platinum the solution pressure is negative in value. In passing into solution, the metallic particles change from an atomic condition to the ionic condition, and in so doing, assumes a positive charge of electricity, leaving the metal itself negatively charged. There will thus be formed an electrolytic double layer and the action will cease. If, however, there be present in the water another ion which has a less solution pressure than the metal under consideration, such ion will pass from its ionic condition to its atomic condition and separate out upon the first metal, giving up its positive charge of electricity thereto. An electric current will therefore pass through the solution from one point on the metal to the other, destroying the electrolytic double layer and causing the solvent action of the metal to be continued.

When a piece of iron is immersed in a solution of copper sulphate, for example, an analogous reaction takes place in which the iron passes into solution, metallic copper plates out upon the metallic iron and an electric current flows from those places where the iron is passing into solution to those portions where the copper is plating out and through this copper to the iron again, although these points may be infinitely near together. If now, the bar of iron be placed in water instead of the copper sulphate solution, a perfectly analogous reaction takes place, except that instead of copper separating out on the iron we now have one of the ions of which water itself is composed, viz., *hydrogen* separating out on the iron and an electric current flowing as before. Water is composed, or breaks up into, the two ions, hydrogen which carries the positive charge, and what is termed the hydroxyl ion, which carries an equivalent negative charge. It happens that there exists a very delicate test for the presence of the iron ion from the fact that potassium ferri-cyanide solution immediately forms therewith a bright blue color; while, on the other hand, there is an organic substance known as phenol phthalien, which becomes intensely red in the presence of hydroxyl ions. If, therefore, a piece of iron be placed in a water solution containing potassium ferri-cyanide and phenol phthalien, and which, to prevent convection currents, be thickened with a little ordinary gelatine, there should be formed a bright blue color at those points on the iron bar at which the iron is passing into solution, and a bright red color on those portions on which the hydrogen is plating out, leaving in the solution at that place an equivalent number of hydroxyl ions. These conditions are easily realized, and a number of such specimens were shown. The fact that iron in the presence of a phenol phthalein solution colored the same red was first noted by Dr. A. S. Cushman, of Washington, D. C., and used by him to prove the presence of ferrous hydroxide in solution. This observation in the hands of Dr. Walker has resulted in this splendid and altogether convincing proof of this first and important step in the corrosion of iron.

According to this conception, therefore, if a piece of iron be placed in water in the absence of air or other foreign material, iron should continue to pass into solution and hydrogen should continue to plate out in the form of gas, but this is not in fact the case. This solvent action in water proceeds but to a very slight extent and then stops, while when iron is placed in a copper sulphate solution under similar conditions the action is continuous. In the case of the copper, which plates out on the iron, we have a good conductor for the electric current which must pass from one point of the iron through the solution and the copper back to the iron again. The film of hydrogen which plates out on the iron in the second case is, however, not a conductor of electricity, but an insulator, and until such film of hydrogen be removed the current cannot pass and the action cannot continue. This hydrogen film may be removed by any reagent which will unite with hydrogen, such, for example, as the oxygen of the air. If, therefore, oxygen be introduced into the water in which the iron has started to dissolve, this hydrogen film will be rapidly destroyed, the electric current will pass and the iron will continue to dissolve or corrode.

A second function of the oxygen, and although only incidental to corrosion, is in reality the more striking, is the conversion of the iron thus thrown into solution in the water into the red hydrous oxide of iron with which we are familiar as rust.

Having now a conception of the mechanism by which iron corrodes, some important conclusions may be drawn from a consideration of the factors involved. Since before the iron can form rust it must first pass into solution, and in so doing cause an electric current to flow from the iron at that point to the iron at some other point; any circumstance which will aid the flow of this current will accelerate the solution of the iron. In other words, any differences in potential which may exist upon the surface of the iron will in itself cause a flow of electricity which will result in a solvent action on the iron. Such differences of potential inevitably result from a segregation or uneven distribution of any impurities which the iron or steel may contain. Hence, we would expect that the speed of corrosion would increase, first, in accordance with the percentage of impurities present, and second, in accordance with the care bestowed upon the iron or steel during its manufacture to prevent a segregation of these impurities. The simplest way, of course, to insure an absence of segregation is to eliminate altogether those materials not needed in the iron. It has been found that a steel made under such conditions that the total impurities are reduced to not over five one thousandths of one per cent. resists corrosion to an extent equal to the iron of our forefathers. The steel companies have been slow to accept this general proposition, but it is gratifying to know that material of this purity may now be obtained on the open market.

Since iron can pass into solution only by assuming the ionic form, and having at the same time an equivalent amount of hydrogen pass from the ionic condition to the gaseous state, the speed of the reaction will depend upon the number of hydrogen ions present in the solution. If this number be enormously increased, as can be done by adding some strong acid, the reaction will be accelerated to such an extent that the hydrogen may be seen passing off the iron as a stream of bubbles. If this concentration of hydrogen ions be but slightly increased by the addition of such weak acids as the carbonic acid of the atmosphere, or the carbonic and sulphurous acids resulting from the combustion of most fuels, corrosion will again be accelerated, though to a less noticeable extent. The presence of any material, such as alum or magnesium chloride, when subjected to pressure, or other materials which by hydrolysis will form an acid, will also accelerate corrosion.

If, on the other hand, the hydrogen concentration be reduced, the corrosion of the iron will also be decreased. Such a condition may be most easily realized by adding to the water a strong alkali, which, owing to the presence of a large number of hydroxyl ions, decreases thereby the number of the hydrogen ions. Iron will not rust, therefore, in a solution of soda ash, limewater, or any materials such as sodium phosphate, which when present in water will by hydrolysis decrease the number of hydrogen ions.

This fact has an important bearing upon the question which has been lately much discussed, as to whether concrete will protect iron from corrosion. Inasmuch as Portland cement when it "sets" or hardens liberates a large quantity of caustic lime, which is a strong alkali, and since good concrete is therefore saturated with this strong alkali, the answer to the question must be in the affirmative. Iron or steel will not corrode when imbedded in concrete. But caustic lime is soluble in water, and poorly made concrete is not impervious to water. Therefore, if iron be imbedded in concrete, through which water at any time be allowed to percolate, this calcium hydrate will be slowly but surely dissolved and washed away, and with it will disappear the inhibiting action of the concrete, and iron imbedded therein will surely rust. To insure absolute protection of the reinforcing members of concrete construction, therefore, such concrete must be sufficiently dense and carefully made to render it practically waterproof. This is not an impossible condition.

The solubility of calcium hydrate present in concrete has an important bearing upon the corrosion of certain of the steel members of the new Cambridge bridge, which has excited comment in some of the Boston papers within the last few weeks. The central portion of the structure, designed to accommodate the tracks of the Boston Elevated Railroad, may be still easily inspected. Between the ends of the I-beams, on which rest the heavy granite curb of the highway on either side, corrosion of the iron has already commenced, although the bridge has been in use but a few years, and according to the newspapers has been twice painted. The cause of the trouble is found in the fact that water from the highway portion of the bridge has percolated down to the concrete and has leaked out between the joints in the supporting I-beams, carrying with it the soluble calcium hydrate. This strongly alkaline solution has saponified the linseed oil paint used on the bridge, and when subsequently removed by rain, corrosion has, as it must inevitably do, ensued. If there be steel members in the cement of the highway proper they will also corrode so soon as the lime of the concrete has been removed by the water.

Since corrosion can take place only when the hydrogen film is continually destroyed, it follows that any agency which will increase the speed of the reaction by which the hydrogen which plates out on the iron and the oxygen which dissolves in the water, will unite, will in turn accelerate the corrosion. This union of hydrogen and oxygen takes place more rapidly on the surface of copper or lead or bronze, than it does on iron. Hence if there be connected with the iron one of these metals, the hydrogen of the reaction will be separated upon it, and the iron will dissolve more rapidly on this account. Ordinary mill scale, which is magnetic oxide of iron, is also a substance on which hydrogen can be liberated more easily than on iron. Hence, if there be a piece of iron, for example a boiler tube or an I-beam, covered with mill scale, and there are breaks in this scale, the iron at these breaks will corrode more rapidly because of the scale with which the breaks are surrounded. This is one cause for the pitting of boiler tubes, and has led the navy in many instances, to remove all of this mill scale from their boiler tubes before being placed in position. The above phenomenon emphasizes the care which must be employed in structural work to prevent the contact of iron with such materials as bronze, lead or copper, unless they be electrically insulated therefrom, and the desirability of removing the mill scale before painting.

On the other hand, electrically connecting a piece of iron with a bronze or copper structure, will protect the latter from corrosion, because, owing to the fact that the iron passes into solution, hydrogen will be liberated upon the bronze or copper and its corrosion will thus be prevented. Employing the same reasoning we find that any metal with a greater tendency to dissolve than iron, for example zinc, on which the hydrogen is liberated with more difficulty than on iron, should protect the iron at the expense of this other more positive metal. This is the explanation of the well-known use of zinc in boilers for the prevention of pitting, and it is but necessary to maintain an electrical connection between the zinc and the iron, to insure the complete protection of the latter, for a distance which depends upon the electrical conductivity, or purity of the water in which the two are immersed. In perfectly pure water, zinc will protect iron but for a distance of one-half inch or so; if salt, or any other electrolyte be added thereto, the area of protection is increased to twenty inches or more.

Since oxygen of the air is necessary to insure the continuous removal of the hydrogen film, it is obvious that if no oxygen be allowed to reach the iron through the water, no corrosion can take place. This fact teaches us much regarding the corrosion of boiler shells and tubes. Pitting may be entirely avoided if the air be removed from the feed water before its introduction into the boiler. This may best be done by the employment of an open feed water heater, or what is better still, a feed water heater connected to the dry vacuum pumps of the condenser. If such treatment is not possible, the air may be removed from the feed water by drawing the water through a closed box containing scrap iron; the oxygen in the water is used up in corroding the scrap iron instead of the boiler tubes. Or, the oxygen in the water may be absorbed by feeding into the boiler with the water a very small quantity of an alkaline solution of a tannin material. Such a solution of alkaline tannate will break up under the pressure and temperature of the boiler, with a formation of a pyrogallate of the alkali, and this rapidly absorbs the oxygen. Soda ash, or other alkali, is of course useful, but not because of its effect upon the oxygen content, but because, as has already been explained, corrosion is inhibited by thus decreasing the hydrogen concentration of the water.

Tin is a metal, which, like copper, accelerates the corrosion of iron by aiding in the oxidation of the hydrogen set free by the reaction. If, therefore, in the manufacture of the so-called tin plate, which is sheet iron or steel covered with a layer of metallic tin, there be imperfections or pinholes in the tin coating, these channels through the tin to the iron will become centers of corrosion which rapidly destroys the plate. It is impossible to detect these imperfections by a simple inspection, and hence users of tin plate have been unable to test the quality of their raw material from this point of view. Since the iron must pass into solution at these exposed points in the tin coating, their presence may be easily located by flowing upon the tin surface a solution of gelatine or glue in which is dissolved some potassium ferri-cyanide. When the jelly has stiffened, the iron will pass into solution through the holes in the tin and reacting with the ferricyanide, will leave a bright blue spot. Variations in the quality of tin plate may thus be easily detected.

The above are a few of the applications which have been made of the electrolytic theory of the corrosion of iron and steel. It is believed that our natural store of iron ore may be conserved and the durability of our iron and steel structures greatly increased by a further application of the knowledge thus made available.

THE MESSINA EARTHQUAKE

Dr. T. A. Jaggar, Jr., professor of geology at the Massachusetts Institute of Technology, gave a lecture before the Society of Arts, January 21st, on the "Scientific Aspects of the Messina Earthquake." About seven hundred were present. The lecture was illustrated by stereopticon pictures showing volcanoes in action and the devastation wrought by them, also pictures of the apparatus used to detect, record and analyze earth movements. Dr. Jaggar made a strong plea for the establishment of geophysical observatories, and stated that the Institute had been promised funds for the equipment of one observatory, in or near Boston.

Following is a digest of Dr. Jaggar's address:—

When the man of science is asked "What caused the earthquake?" he must confess to ignorance. It was either subterranean steam, or unequal yielding to internal contraction of immense blocks of the earth's crust, or deep-seated movements of lavas slowly rising under Etna. Or, what is still more likely, it was all three of these in mutual dependence. If we maintained earth observatories as we do astronomical ones, we might know, and we might perhaps have predicted and forewarned.

This new catastrophe is the thirteenth of the century, and brings the death-list to about 300,000, or 100 persons a day since January 1, 1901. An eruption of Etna is also beginning and may still further swell the fatal roll. The record includes Guatemala, Martinique, St. Vincent, Mobile, Galveston, San Francisco, Valparaiso, Jamaica, Kartaghan, India, Calabria, Vesuvius, and Messina. The property loss is countless millions. Eight of these places are American. At all of them the destruction has been wrought by natural agencies. In the cases of Mobile and Galveston there was definite prediction by the Weather Bureau. This office, which systematically records the movements of the atmosphere at widely distributed stations, is now recognized as one of the most efficient, valuable, and humane scientific organizations in the world. Similar meteorological establishments are maintained by all civilized nations. The other disasters were occasioned by volcanoes or earthquakes. The coast-lines of the world are dotted with volcanoes, and no region is known which is exempt from earthquakes. No geologist in the United States would venture to deny, for example, the statement that New York city is just as liable to a great earthquake disaster as was Charleston in 1886. With these facts before us, it would seem justifiable to call science to account for its attitude with regard to the lithosphere (or rock-crust) as contrasted with its point of view concerning the atmosphere. Sometimes a great affliction, like this which has stunned and mutilated Italy, may work beneficently by stimulating men to a new vision of their usefulness.

A great convention of American geologists has just completed its deliberations in Baltimore. All of these men are interested in earthquakes, but probably not half a dozen members of the society have any technical or mathematical knowledge of them, and not many more have ever experienced one. The idea that such experience is important for a geologist would be scouted as a jest. Many of these men are teachers in universities. If a Martian astronomer were to appear suddenly among them, after returning from a visit to the Lowell observatory at Flagstaff, where his own existence had been so wonderfully interpreted, the following dialogue might be expected :—

"Where you know the heavens so well, of course your own earth is to you as an open book?"

"Yes," reluctantly.

"You have observatories for the recording of all earth phenomena?"

"No."

"What! Did you not learn everything about local terrestrial motions before you studied the stars?"

"No, we do not know anything about terrestrial movements."

"Do you mean to tell me that you have not many instruments for observing them?"

"We have the seismograph, but none of us understands it, and as for other earth motions, all we know we have learned from the physicist and the astronomer."

"But you live on the earth, and have to meet every crisis as it arises; can you foretell nothing?"

"Well, you see, we don't think of it that way. We treat it historically, and make notes, and use a hammer and a compass, and are very much interested in the bones of Jurassic reptiles and in making maps of the rocks, and in finding out all about iron and coal. But we have no such precise knowledge as the astronomer."

"But surely, in teaching your young men in the universities, you begin by precise instrumental study of the present earth and its processes, and have a vast accumulation of experience concerning those processes, in the form of tables, measurements, formulæ, curves, diagrams and computations?"

"No, almost nothing has been done in accumulating experience or empirical data, *except by the Japanese*. When a volcanic eruption or an earthquake occurs we send a geologist to study the results, and he writes a thick and learned report. We do not know anything about what the conditions were during the months before the disaster. We teach our young geologists first a little physics and chemistry, and a few generalities about earth process, and then set them to work mapping ancient rocks. The *highest* development of geology is the unraveling of the history of the past. We haven't time to go into prediction and humanistic geology."

The above is not exaggerated. The blame does not rest with the geologist, it rests rather with the haphazard growth of the science. The very proximity of the earth has made terrestrial observation and measurement difficult, in view of the littleness of man. This plea, however, can no longer be urged in extenuation of the neglect of the study of earth process. We have a considerable knowledge of physical science, and there are many instruments applicable to the earth. There is a very precise science known as geodesy, which has for its object the determination of the figure of the earth. There is geology, which aims to decipher earth history. Between these two there is needed a new science, many phases of which are now being studied, and this might well be named geonomy, the science of the laws which govern the earth.

There is one grave difficulty in the way of rapid development of this science, and that is expense. It is a science that calls for the establishment of observatories in many lands. These observatories will have for their objects the study of the changes which are going on in the crust of the earth under them, and the relations of those changes to astronomical and meteorological changes. The new science, like astronomy and the study of the atmosphere, deals with moving things, and so requires continuous local records, through weeks and months and years. Seismographs, microphones, magnetographs, gravity pendulums, pyrometers, tromometers, gas-collecting apparatus, and many special instruments adapted to local needs, are among the devices with which an earth observatory should be equipped.

The natural places for establishing such observatories at first are lands where the earth movements are most rapid, regions of volcanoes and frequent earthquakes. In such establishment the Japanese have taken the lead, and their island empire is girdled with observatories. The writer has before him a pamphlet, in English, printed in Tokio in October, 1908, containing eleven contributions to practical seismology by a Japanese investigator, F. Omori, the first of which bears the significant title, "On the Fore-Shocks of Earthquakes." Dr. Omori declares, "My belief is that a large destructive earthquake will be foretold in its epicentral region by some fore-shocks," and this belief he substantiates by exact instrumental proofs.

With reference to Sicily, it is well to make note of the fact that an American volcanologist, Frank Alvord Perret, has predicted disaster on Mount Etna for two years past. Mr. Perret, who was decorated by the crown of Italy for his splendid service to science and to humanity on Vesuvius in 1906, wrote in the *World's Work* of November, 1907:—

> By the rational methods of scientific research, we know that a great eruption of Mount Etna is impending, the only uncertainty at present being which side of the mountain will break open.

Great volcanic eruptions are preceded by great earthquakes, and the Messina disaster of December 28th comes on an earthquake date ("terrestrial maximum of gravitational stress"), actually platted in advance by Mr. Perret on his diagrams for 1908. Like Dr. Omori, he is a man whose whole time is unselfishly devoted to these studies, but he has no observatory and no adequate means of support. A few business men in Springfield, Mass., last year came valiantly to his aid, and now their foresight is worthy of all honor. When young men think of making science their life-work, it would be well to remember Pasteur, and to consider carefully whether the highest development of the investigative faculties may not concern itself with humane rather than with historical motives. To those who will give time and money to the establishment of earth observatories, there will come by way of reward some of the most astonishing discoveries of the twentieth century.

The Boston Observatory.—Plans have been prepared in Boston for an earthquake-proof observatory and museum, built on Japanese lines, to be equipped with instruments for measuring earth tremor, earth waves, earth sounds, earth tilt, earth gravity, earth magnetism, and changes of the earth's axis. It is proposed to secure an endowment which will provide for expeditions as a most important part of the work of the observatory, whereby trained men will be sent to volcanic lands to carry on research which may not be done at home. The Geological Society of America has passed urgent resolutions strongly recommending "to governments and to private enterprise the establishment of volcano and earthquake observatories." What should be done by the United States as a whole? It may be well to describe briefly the vision of what *could* be done to set an example to the world: Provide $4,200,000. Erect ten small observatories costing $20,000 each, in New York, Porto Rico, Canal Zone, San Francisco, Alaska, Aleutian Islands, Philippines, Hawaii, Scotland and Sicily. With $200,000 per annum, the income of four millions, supply each observatory with $10,000 per annum to maintain its director, assistant and expenses, and reserve $100,000 for the central office for administration, exploration and publication. Define the objects of the work to be direct measurement and record of earth process with a view to the benefit of humanity. Define three immediate goals for the investigators: (1) Prediction of earthquakes; (2) prediction of volcanic eruptions; (3) engineering and construction in volcanic and seismic lands. The objects of the two European stations are to cover the important volcanic fields of Iceland, the east Atlantic and southern Italy, and to keep in touch with the advance of European science. The work would be strictly American, and if it were carried out, it would be epoch-making in the history of science.

There is a very immediate opportunity for scientific work by engineers at Messina. No investigators are better fitted to examine this question than the engineers of the United States and the graduates of the Institute of Technology. Nature has performed a frightful but also a most instructive experiment in what forms of construction are most resistant to earthquake. A commission to investigate and report on this, with a view to construction in our own earthquake lands, as well as to aid Italy, ought to go at once to Sicily and make an exhaustive study of the question.

The Department of Geology is now seeking $10,000 per annum for ten years, or an endowment of $200,000, to maintain the Geophysical Observatory of the Massachusetts Institute of Technology. Boston may take the lead in establishing the first American earth observatory. One donor has promised to build and equip the Boston observatory, at an expense of not less than $10,000, provided that an income fund or an endowment may be found, and $1,000 has been promised as the first single subscription toward the income fund.

DR. STEINMETZ ON THE FUTURE OF ELECTRICITY

An audience that nearly filled Huntington Hall greeted Dr. Steinmetz on January 28th, when he lectured before the Society of Arts on "The Future of Electricity." Many of his hearers had expected some startling predictions as to new manifestations and utilizations of the electric force, but in his first remarks Dr. Steinmetz stated that in making any prediction as to the future of electricity, we must first consider the present state of the art and the development that is going on just now, and we are only warranted in estimating the future of electricity by the trend of present development, although some new invention or discovery may entirely change the direction. Dr. Steinmetz reviewed briefly the development of electricity as a source of light and power, from the early electric trolley cars, fifteen or twenty years ago, to the great electric locomotive of to-day. He said that we may live to see the last steam locomotive disappear from the United States, east of Chicago.

The progress in lighting has been almost as rapid, for although in many cases the cost of electric light is higher than that of illuminating gas or gas made from calcium carbide, in most cases, where electricity is developed from water power or where it is generated in large amounts in great central stations, it is cheaper than any other source of light.

He stated that the economic production of heat by electricity has not advanced so rapidly as in other directions, as direct combustion of coal or other fuel is more economical, but where perfect control of temperature is desired, or where intense localized heat is necessary, the electric current must be used.

In speaking of the development of power Dr. Steinmetz stated that there were only two ways in which we could transmit energy for any long distance. One was in the transportation of the fuel itself to an unlimited distance in freight cars, and the other was the transmission of electric energy in conductors. On the coast where coal is scarce and water powers are plentiful and highly developed, a large area of the state of California is in one interlocking, gigantic system of electric power distribution supplying energy to cities, factories, mines and mills.

He predicted that it would not be many years before the whole country would be one vast network of electric transmission systems, all interlocking and taking energy from various points in the system where it could be cheaply developed by water power. He believed that the needs of future generations would develop water powers where we do not now look for them. The great problems to be solved in the future are those of fertilizing the soil, and of producing heat. There are very few places in the country where the elements that have been taken from the soil by the crops do not have to be restored to it in order that it may bear future harvests. For the purpose of fertilization of the soil we must have phosphates, nitrates and potassium salts. The phosphates of the soil go into plant and animal structure, and are eventually restored to the land. An almost inexhaustable supply of potassium exists in rocks that are disintegrated by the elements, and is carried back to the soil. There are two methods of producing nitrates. One by vegetable bacteria, which take the nitrogen from the air and carry it to the soil. It is probable, however, that when living organisms are reproduced for long periods in the same soil the land will eventually become incapable of maintaining them.

There are two ways of producing the nitrates by electricity. One is by the electric arc, producing nitrates directly from the nitrogen of the air, and in a more indirect way by converting limestone first into calcium carbide, which takes up nitrogen from the air, forming cyanamid, which is used as a fertilizer. Both processes are in commercial use, and are being carried out on a large scale where water powers are cheap.

We cannot to-day produce nitrates with economy in sufficient quantity to restore all the soil that must be fertilized, but many things become possible and economical when necessary, and this is one case in which we will have to rely ultimately on electric power.

Dr. Steinmetz also spoke of the time when coal and other fuel shall have been exhausted, and we shall be obliged to use the energy of electricity generated by great water powers all over the country for heating purposes. He stated that the present method of producing heat was very expensive, but that the problem would be, however, not to produce heat from electric power, but to raise the existing heat in the air to a temperature at which it is suitable for us.

In conclusion, the speaker said: "When that distant time comes when we shall be out of fuel, we shall have to look to the electrical engineer, and to the water powers of the country, to supply the source of energy which we need to heat our houses, to run our railroads and factories, to produce fertilizers, to raise our crops and keep us from starving and from freezing; it will then be the electrical engineer who will have to do that, and he will be the most important man, and electricity will be the art to which mankind will have to look to maintain itself."

COMING EVENTS

There will be a regular meeting early in March and one or two extra meetings during February and March.

"The Larger Research Problems of the Carnegie Institution" will be presented by Prof. Robert S. Woodward, president of the Carnegie Institution, March 25th.

Prof. George E. Hale, director of the Mt. Wilson Solar Observatory of the Carnegie Institution, Pasadena, Cal., will address the society on the subject, "Solar Cyclones and Magnetic Fields," with lantern illustrations, in April.